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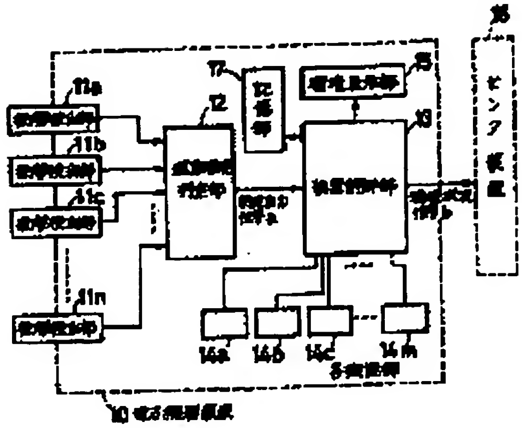


See text for key

Detailed Report

(Name of invention)
portable electronics device

Abstract
(Object)

This invention detects impact or vibration during use, storage, and transportation. It determines whether the device can be used or not based on the detected result, and can stop device motion, etc.

(Construction)

Output from at least one of the impact detection sections 11a to 11n such as strain gages is compared to a specified impact value for the device which has been set up beforehand by the environment judging section 12. These sensors can be arranged on the surface or corner of an electronic device 10. When the device is judged as not usable, a device control section 13 which receives the output signal a displays a message "not in operating condition" on the environment display section 15. At the same time, it stops each function section 14a to 14m of the device. Result of the judgment is recorded in the memory section 17.

Sphere of the patent application

(Claim 1)

Claim 1 is concerning a portable electronic device which has the following characteristics: It has a detection step which detects either impact or strain; a recording step which automatically records either the impact or strain signal; a judgment step which automatically judges whether the device can be used or not by comparing and analyzing the signal to an acceptable range for normal use or an impact specification value set up for transportation conditions; a display step which automatically displays a message when the device is judged as not usable, or a step which generates an alarm or comment at the same time it stops appropriate functions of the device or related functions.

(Claim 2)

Claim 2 is concerning a portable electronic device which has the following characteristics: It has a detection step which detects either impact or strain; a recording step which automatically records either the impact or strain signal; a judgment step which automatically judges whether the device can be used or not by comparing and analyzing the signal to an acceptable range for normal use or an impact specification value set up for transportation conditions; a step which cautions the operator when the signal exceeds a 1st reference value; a step which informs the operator that the device cannot be used when the signal exceeds a 2nd value: at the same time, the device in this invention stops the device.

(Claim 3)

Claim 3 is concerning the portable electronic device in claim 1 or 2 which has the following characteristic: It has a step which determines whether the area previously judged as not usable can be re-used and a step which automatically clears the stop signal.

(Claim 4)

Claim 4 is concerning the portable electronic device in claim 1 or 2 which has the following characteristic: the detection step is a strain gage which is set up on the surface or corner of the device in order to detect the magnitude of the strain.

(Claim 5)

Claim 5 is concerning the portable electronic device in claim 1 or 2 which has the following characteristic: the detection step is a film for measuring pressure which is set up on the surface or corner of the device in order to detect the magnitude of the strain.

(Claim 6)

Claim 6 is concerning the portable electronic device in claim 1 or 2 which has the following characteristic: the detection step is a pressure sensitive electrically conductive rubber which is set up on the surface or corner of the device in order to detect the magnitude of the strain.

(Claim 7)

Claim 7 is concerning the portable electronic device in claim 1 or 2 which has the following characteristic: the detection step is a vibration sensor which detects the magnitude of the vibration and a square wave amplifier for the output voltage from this vibration sensor which outputs a flat electric signal.

(Claim 8)

Claim 8 is concerning the portable electronic device in claim 1 or 2 which has the following characteristic: the detection step is a semiconductor thin film magneto resistive displacement sensor, and an amplifier for the output voltage detected by this semiconductor thin film magneto resistive sensor and an A/D converter.

(Claim 9)

Claim 9 is concerning the portable electronic device in claim 6 or 7 which has the following characteristic: the recording step in claim 1 or 2 has a step which automatically records accumulated vibration strain (fatigue).

(Claim 10)

Claim 10 is concerning a portable electronic device which has the following characteristic: a pressure sensitive film detects either impact or strain and displays the degree of impact which corresponds to the specified values for an acceptable environment for the device or for storage and transportation in color. This sensor is applied on the surface or corner of the device.

Detailed explanation of the invention

Publicized Report of Patent

[0001]
(Field of industrial use)

This invention is concerning a portable electronic device for use when acceptable values of impact resistance is specified for normal use, storage, and transportation.

[0002]
(Prior art)

In the past, this kind of portable electronic device was guaranteed by specifying an acceptable range of use, storage, and transportation in terms of impact-resistance.

[0003]
(Problem that this invention tries to solve)

However, in the former cases, although the acceptable range of impact resistance for use, storage, and transportation for the portable electronic device is specified, the user generally finds it difficult to determine whether the impact is within this acceptable range. Therefore, there have been problems with abnormal motion or deterioration of performance produced by using it outside the acceptable range of conditions.

[0004] In general, compared to office equipments that are used inside, acceptable accelerations for portable electronic devices such as cell phones or portable terminals (handy terminal) have been in the range of, for example, up to 20 G. In addition, labels such as "please handle the device with caution", "please do not drop it", etc., are applied to the equipment. However, there are many occasions when these products are dropped during use or hit corners of hard objects while being carried or are carried in the basket of bicycles or motorcycles. Due to these circumstances, problems with the device have occurred.

[0005] In addition, due to rough handling, printed circuit boards inside are cracked, or the insulation distance for high voltage parts is reduced. When it is used without repair for a long period of time after the incident, it may smoke or catch fire.

[0006] When the nature of the problem makes it clear that the damage is due to rough handling, both user and manufacturer can agree. For instance, when the glass cover on a liquid crystal display is cracked, it is assumed that the user dropped it, or a hard object hit the glass cover, and this is inappropriate handling by the user.

[0007] However, when it is impossible to clearly determine the cause of the damage from the nature of the damage, the real cause cannot be found. For example, there are cases when the printing function of a portable electronic device is not working right because the user hit the device somewhere sometime. As a result, the paper feed mechanism is strained, and part of the wiring is cracked. This may causes bad contact sometimes, and part of the letters are disordered. In this case, it is very difficult to prove inappropriate handling by the user. Therefore, it is impossible to reason with the user.

[0008] This invention solves these former problems. When the device is subjected to an impact outside the acceptable range for use, storage, or transportation, this fact is displayed by the portable electronic device. This device also makes the electronics stop working.

[0009]
(Steps for solution)

In order to attain this object, this invention has the following characteristics: It has a detection step which detects either impact or strain; a recording step which automatically records either the impact or strain signal; a judgment step which automatically judges whether the device can be used or not by comparing and analyzing the signal to an acceptable range for normal use or an impact specification value set up for transportation conditions; a display step which automatically displays a message when the device is judged as not usable, or a step which generates an alarm or comment at the same time it stops appropriate functions of the device or related functions.

[0010] Also, this invention has the following characteristic: It has a detection step which detects either impact or strain; a recording step which automatically records either the impact or strain signal; a judgment step which automatically judges whether the device can be used or not by comparing and analyzing the signal to an acceptable range for normal use or an impact specification value set up for transportation conditions; a step which cautions the operator when the signal exceeds a 1st reference value; a step which informs the operator that the device cannot be used when the signal exceeds a 2nd value: at the same time, the device in this invention stops the device.

[0011] Also, this invention has the following characteristic: It has a step which determines whether the area previously judged as not usable can be re-used and a step which automatically clears the stop signal.

[0012] Also, this invention has the following characteristic: the detection step is a strain gage which is set up on the surface or corner of the device in order to detect the magnitude of the strain.

[0013] Also, this invention has the following characteristic: the detection step is a film for measuring pressure which is set up on the surface or corner of the device in order to detect the magnitude of the strain.

[0014] Also, this invention has the following characteristic: the detection step is a pressure sensitive electrically conductive rubber which is set up on the surface or corner of the device in order to detect the magnitude of the strain.

[0015] Also, this invention has the following characteristic: the detection step is a vibration sensor which detects the magnitude of the vibration and a square wave amplifier for the output voltage from this vibration sensor which outputs a flat electric signal.

[0016] Also, this invention has the following characteristic: the detection step is a semiconductor thin film magneto resistive displacement sensor, and an amplifier for the output voltage detected by this semiconductor thin film magneto resistive sensor and an A/D converter.

[0017] Also, this invention has the following characteristic: the recording step in claim 1 or 2 has a step which automatically records accumulated vibration strain (fatigue).

[0018] Also, this invention has the following characteristic: a pressure sensitive film detects either impact or strain and displays the degree of impact which corresponds to the specified values for an acceptable environment for the device or for storage and transportation in color. This sensor is applied on the surface or corner of the device.

[0019]

(Function)

The portable electronic device in to this invention with the above construction detects impact or strain on the surface of the device and in its vicinity. The output of the detector is used to determine whether the device can still be used or not. When it is not usable, this information is displayed. At the same time, operation of the device is stopped preventing it from being used. In addition, this invention avoids occurrence of problems due to continued use of the device after the incident, and it increases reliability and prevents shortening the useful life of the device.

[0020] Also, by using two-step control, rather than stopping the device by the result of the 1st step, confirmation of the accumulated fatigue received by the device becomes possible at an earlier stage. The user stops using the device following the first warning and moves the device to a better environment, putting a soft cover on it. After that, when it is again in a usable environment, all functions will be normal as before without malfunction. This will extend the life of the device.

[0021] To detect shock or strain, you can use a strain gage, pressure-sensitive film, pressure-sensitive electrically conductive rubber, vibration sensor, semiconductor thin film magnetic resistivity type sensor, etc.

[0022] Since the accumulated fatigue due to vibration is automatically recorded, the recorded contents provides a reliable history and a more secure judgment of whether the device can be used or not.

[0023] Since a pressure measuring film is attached to the surface of the device, when impact and strain on the surface of device reach a specific value, it detects the irreversible impact and makes a secure permanent record of impact and strain. If the breaks down because of rough handling by the user, proof of impact by falling, etc., can be confirmed. In addition, since the film can be re-applied, it is possible to select irreversible temperature changing material which is suitable for each application.

[0024]

(Example of practice)

In the following, examples of practice of this invention are going to be explained referring to figures.

[0025] Figure 1 is a block diagram which shows the construction of the 1st example of practice of this invention. In the figure, 1 is a electronic device; 11a to 11n are multiple shock detection parts. It detects impacts on each surface of the portable electronic device 10 near the impact detectors 11a to 11n. 12 is the application environment judging part. It collects impact data received from each surface of the portable electronic device 10 and judges whether the portable electronic device 10 is in a suitable environment or not, and a judgment output signal 1 is output. 13 is a device control section. It controls each function 14a to 14m, at the same time, it informs the operator by controlling the display section 15 based on the judgment output signal a, and it sends a status signal b of the terminal device to the center device 16.

[0026] Also, if necessary, it may have an alarm based on the above judgment output signal 1. Furthermore, if the detected value is outside the specified range and is dangerous to the device, a control step can automatically stops the main part of the device

based on the judgment output signal 1 or environment status signal b. It can also stop only the sensitive functions of the device.

[0027] Figure 2 is a block diagram which shows the construction of the display step in the 1st example of practice. A signal concerning impact is detected by the impact detection sections 11a to 11n and is sent to A/D converters 101a to 101n and it is transformed to digital impact data. This value is supplied to read only memory (ROM) 102 as address data. ROM 102 is assigned as address by the output of the A/D transformation part 101, and it has area Ma to Mn which retains impact data on each surface and near it and area Mo which contains comments. Impact data read from ROM 102 is sent to a character generator 103, and its contents are transformed to data for the dot matrix display section 104 which is the environment display part 15 and they are read on latch 105. Data read on latch 105 are written in order to random access memory (RAM). Contents of RAM 106 are sent to the display driver 107. After they are transformed to display data, they are displayed on the matrix display section 104. Impact data read from ROM 102 are input to the control section 108.

[0028] The control part 108 outputs a motion command signal to a character generator 103 and latch 105 based on an input signal from a keyboard 109, and it outputs command signals to control each function such as the display switch signal to the display driver 107.

[0029] The comment data part 110 sends comment data from the control section 108 to the area Mo of ROM 102 as address data. Then it calls the comment data from its assigned address area and supplies it to a D/A converter. This D/A converter 111 transforms comment data read from ROM 102 to an analog voice signal. It is sent to a speaker 113 through an amplifier 112 to generate an audible alarm.

[0030] Next, operation of the 1st example of practice is going to be explained referring to the flow chart in figure 3. First, the matrix display 104 and speaker 113 are reset to the initial condition (S1-1). When any one of (part A) the impact detectors 11a to 11n on each surface of the portable electronic device detects an input which is not within the acceptable range of use for the device (No. of S1-2, S1-3), the environment judgment part 12 sends an output "a" meaning that it is not in a usable environment to the device control part 13. The device control part 13 displays a message such as "please put a soft protective cover on top", "please put the protective cover on", "caution ", "please do not drop", etc., on the display 15. When power is turned on an alarm is produced (S1-4) to inform the user or person engaged in storing or transporting the device (S1-5).

[0031] It can determine which place on the device (such as part A, etc.,) has received abnormal physical stress and can sense treatment to protect part A so that the stress is removed (S1-6). Therefore, after impact is detected at the detectors 11a to 11 n of the site (S1-7), when the stress is relieved and it is judged that part A has been recovered (YES in S1-8), the display and alarm sound above disappear (S1-9). However, when part A does not recover (NO of S1-8), it sends a stop command to all parts of the application 14a to 14m.

[0032] By setting memory 17 to record the environment status signal b (S1-11), it is possible to send the environmental conditions to the terminal at the center device 16 (S1-13). Data from the impact memory part 17 can be used as proof of rough handling by the user. The environment status signal b includes the result and date and time of each

impact in section 11a to 11n. Detection of impact by detectors 11a to 11n above is performed repeatedly (S1-12).

[0033] Accordingly, this device can prevent use, storage, and transportation of the device in inappropriate environments. It avoids problems due to continuous use in the environment, and it can improve reliability of device and lengthen its useful life.

[0034] In general, compared to office equipment used indoors, especially, portable electronic devices that are carried outside such as cell phones or handy terminals are often dropped, hit, or thrown. In such cases, impact detectors 11a to 11n set up on the exterior of the device detects them and displays a stop-use request and emits an alarm. At the same time, it stops operation of the device. This prevents problems that may occur due to continuous use of the device after a previous incident. Simultaneously, it informs the user and it can prevent rough handling situations.

[0035] As seen in step (S1-6) to (S1-10) of the flow chart above, after the alarm is displayed, the device or parts of it are stopped, and sensitive functions are protected. By this, fatal problems can be prevented. The impact detectors 11a to 11n detect when the device returns to a usable environment and the absence of abnormal physical stress. Then the device control section 13 erases the environment display part 15; at the same time, the stop command that has been sent to each part 14a to 14m is cleared.

[0036] Accordingly, in the above example of practice, when the environmental impact where the portable electronic device 10 is used exceeds an acceptable value, after comparing and analyzing it with the output from the detection step, a judgment is made automatically whether the device can continue to be used or not. If it is judged that it should not be used, the message is automatically displayed on the display 15 and an alarm is sounded. At the same time, operation of each function 14a to 14m is stopped. Therefore, it can prevent use of the portable electronic device in an inappropriate environment. At the same time, problems that may occur due to continued use can be prevented.

[0037] In addition, according to this example of practice, the environmental status signal b can be used to control the device to maintain suitable environmental conditions as specified.

[0038] Also, in this example of practice, it is possible to attach the impact detectors to other parts of the device such as the case.

[0039] In addition, in this example of practice, the result of each impact detector 11a to 11n is sent to the display 15 so that it is clear which area of the portable electronic device 10 is exceeding the acceptable value, and repair and recovery of the spot can be done easily.

[0040] Although the device is designed to withstand a certain degree of impact, there is limit to its shock resistance. It is important that the device is handled properly by the user. This invention is very effective in calling people's attention to this fact.

[0041] Next, a 2nd example of practice of this invention is going to be explained. This 2nd example of practice has the following characteristics. It detects strain on the surface of the device. It has a step which displays the detected result on the surface of device, and a display which tells whether the device can be used or not. Figure 4 is a cross section which shows the portable electronic device of the 2nd example of practice. In this 2nd example of practice, instead of impact detectors 11a to 11n in 1st example of practice,

strain detectors (will be discussed later) are used (since the rest of the construction is the same as the 1st example of practice, its detailed explanation is omitted here.) It is different from the 1st example of practice in the following points. That is, an impact detector was used in the 1st example of practice while a strain gauge is used in the 2nd example of practice. Also, the coping process is displayed in the 2nd example of practice.

[0042] In figure 4, 20 is the main body of the device; 21 is a keyboard; 22 is a display section or touch panel section; 23 is a roll cover which covers a recording paper roll; 24 are strain detectors set up on the outside of each part 20 to 23 above (the strain detectors 24 are placed in the same areas as the impact detectors 11a to 11n of the 1st example of practice).

[0043] In the 2nd example of practice, strain detectors 24 are arranged near parts which are damaged by vibration or strain. The result is reported and displayed by the display and touch panel 22 as a caution message. Not only is strain detected and a number value or color displayed, but also a warning message is displayed as a picture or illustration, calling even more attention to the warning. The display also commands coping actions in the message so that the user will perform specific protective actions. It prevents problems that may occur by continued use of the device.

[0044] In addition, just detecting strain and displaying a number or color, doesn't explain the significance of these alarms to the user, and it is unreasonable to expect that the user will take the appropriate actions. There have been former suggestions of an electronic device with a step to detect strain, etc. However, it is not realistic to expect the user to determine whether the detected strain is in the acceptable range for use, storage, or transportation. In general, there are few users who are aware of the specifications. Furthermore, just displaying the detected strain will not cause the user to perform preventative actions.

[0045] Figure 5 shows the structure of the above strain detection part. The resistivity of the strain detectors 24 changes under strain. The resistivity value R of the metal resistor changes as it is stretched and becomes thin.

[0046] When the length of the resistor is adopted as l, its section is adopted as a, and specific resistance is adopted as p,

[0047] The ratio for resistivity is given by the formula below.

[0048]

math formula

$\Delta R/R = \Delta l/l - \Delta a/a = \Delta p/p$

[0049] As shown in figure 5, a metal resistance wire 26 or resistance foil is attached to a thin insulating plate 25 by adhesive. It is welded to the end of a metal resistance body of copper nickel alloy with a pull-out conductive wire 27, and it is introduced to the detection circuit. A resistance change proportional to the strain is detected as a voltage change by a bridge circuit.

[0050] In general, compared to office equipment used indoors, especially portable electronic devices that are carried outdoors such as cell phones or portable terminals (handy terminals), problems due to vibration or strain tend to occur. Strain is also produced by rough handling. As a result, printed circuit boards are cracked or the insulation distance of high voltage parts is reduced. When it is used continuously for a long period of time, smoking or fire may occur.

[0051] In this case, in the 2nd example of practice, strain detectors 24 are set up on the exterior of the device where the strain occurs. They detect strain and display a message that says the device has failed and emit an alarm. At the same time, operation of the device is stopped.
[0052] Next, the operation of the 2nd example of practice is going to be explained. As shown in the flow chart in figure 6 (step (S1-1) to (S1-12) of flow charge in figure 3 and step (S2-1) to (S2-12) of step in figure 6 correspond each other), other than the fact that strain is detected instead of impact, it is the same as the 1st example of practice, and its detailed explanation is omitted here. When any one of the strain detectors 24 on the main body 20 of the device detects a result which is not within the acceptable range, it displays a message such as "please check the device", "please put protective cover on", "caution vibration", on the display and touch panel 22 notifying the user or person engaging in storage and transportation. At the same time, each application is stopped, and coping commands are sent for security and control. It also emits an alarm and sends a warning.
[0053] As is obvious from the 2nd example of practice, strain on the surface of the portable electronic device is detected and displayed on the surface of the device. Whether the device can be used or not is easily determined and a warning is displayed. This can prevent accidents such as smoking and fire or problems that may occur due to continuous use of the device. At the same time, a warning is given to the user, and rough handling can be avoided. Displaying the result near the strain detector is effective in letting the user know the signal is high. It lets the user take specific protective actions when it is used outside of an acceptable environment.
[0054] Next, a 3rd example of practice of this invention is going to be explained. This 3rd example of practice has the following characteristics. A film-like part for measuring pressure or pressure sensitive conductive rubber is attached to the surface or corners of the device. Whether the device can be used or not is displayed as a warning.
[0055] The 3rd example of practice is explained for the case which uses a pressure sensitive conductive rubber. Pressure sensitive conductive rubber combines silicon rubber and metal particles. Figure 7 shows the characteristics of pressure sensitive conductive rubber. Its resistivity rapidly changes from insulating (more than 10 MΩ) to conductive (less than several ten Ω) under pressure. The characteristics of the elastomer is used to detect impact on the surface of the device. A specific example of pressure sensitive conductive rubber is "pressure-sensitive sheet" manufactured by Nippon Synthetic Rubber Co. Ltd.
[0056] As shown in figure 8, the conductive mechanism of dispersion type conductive materials such as pressure sensitive conductive rubber 30 become conductive either when a path is formed as conductive particles directly contact each other in the in rubber elastomer under pressure (coming within several angstrom is regarded as electrical contact). Therefore, the pressure doesn't have to be only vertical or horizontal, but a conductive path is formed even when it is in the planar direction of the sheet.
[0057] Accordingly, as shown in figure 9, the upper and lower sides of the pressure sensitive conductive rubber 30 each have electrodes 31a, 31b. Electrode 31b on one side is connected to the main body 20 of the resin case which consists of non-conductive material. A protective sheet 32 which consists of non-conductive material is set up on the other electrode 31a which is on the impact receiving side, and an electrode 33 is

connected between both electrodes 31a, 31b. A detection signal output 34 is arranged between electrodes 31a, 31b to make a two-sided electrode. Or as shown in figure 10, an electrode 35 is arranged under the lower side of the pressure sensitive conductive rubber 30. Reinforcing material which consists of conductive material and a protective sheet 32 which consists of non-conductive material are set up on top of the pressure sensitive conductive rubber 30, and an electric source 33 is connected to the electrode 35. At the same time, a detection signal output 34 is arranged to make a one-sided electrode structure. Or as shown in figure 11, an electrode 37 which is both for vertical and horizontal directions is set up under the pressure sensitive conductive rubber 30. With this structure, pressure (impact) is detected.

[0058] Figure 12 shows a specific example of a detection circuit which is connected to the pressure sensitive conductive rubber 30 of the above structure. The pressure sensitive conductive rubber 30 is attached to a circuit which consists of a set resistivity 40, inverter 41, switching transistor 42, and a chatter prevention circuit 43. Since the switching point is rapidly changing, hysteresis is inserted in the circuit to prevent chattering, considering each coping process which corresponds to levels of the detected impact to produce a constant output value. The pressure sensitive conductive rubber can also be set up in rows.

[0059] When the pressure sensitive conductive rubber 30 is set up above and below the resin case of the main device 20, it is covered with a shock reducing sheet 32 such as polyester film, and excess stress concentration is avoided. The thickness of this structure is adjusted so that it will detect an impact of a specified value (less than 20 kg/cm^2).

[0060] It is necessary to consider each application as follows. Depending on the thickness or material of the protective sheet 32 or reinforcing material 36, the pressure sensitive conductive rubber itself is designed to detected the strain specified for each device. An appropriate safety margin may be designed in, for that matter.

[0061] Each portable electronic device is constructed so that pressure sensitive conductive rubber 30 is set up on the surfaces surrounding parts such as the printing head of a printer, input and output connectors of a photo communication device, the panel of a liquid crystal display, or an antenna. The pressure sensitive conductive rubber is also set up on the side of the main device 20 or on top of and below the resin case as reinforcing shock resistance.

[0062] In the 3rd example of practice, when the device breaks down due to an incident – for example, the user drops the device, the fall impact is displayed in clear sight, and proof of the incident can be confirmed. Also, in this case, even if the device does not have trouble, displaying the record of this fall impact informs the user of the need to be more careful. Since the pressure sensitive conductive rubber sheet can be reapplied, the shock resistant material can be selected in accordance with the shock resistance specification for each application. Pressure sensitive conductive rubber at surface or corners of a device also reduces shock and prevents sliding.

[0063] By using pressure sensitive conductive rubber instead of shock detectors in the 1st example of practice, when it the impact is almost at the limit of the fall impact resistance specification for the device, a message such as "not usable", "caution on handling", "cannot be used because of fall", etc., is displayed, informing the user or people engaged in storage and transportation.

[0064] This warning message prevents users from using the device as they used to, and they handle the device more carefully such as putting on a cover which reduces impact. This prevents trouble before it occurs and improves durability of the device.
[0065] If the user continues using the device in the same manner, the least impact resistant part automatically shuts down. Next, the device itself automatically stops and cannot be used continuously. In addition, the previous fall or the automatic shutdown of the weak part is recorded by the recording part. By this, it becomes clear that trouble has occurred due to inappropriate handling. The fall or the weak part impact becomes clear. This becomes useful for developing solutions to cope with these problems.
[0066] The user stops using the device and copes with problems quickly following the warning and instructions above. He avoids rough handling or rough operation and takes good care of the device and takes action such as putting on the soft cover furnished with the device. After that, when it becomes usable, all functions can be kept normal as before.
[0067] Next, the 4th example of practice of this invention is going to be explained. In the 4th example of practice, the device detects vibration using a vibration sensor and records the accumulated fatigue.
[0068] The vibration sensor transforms mechanical vibration to electric signals. There are several kinds such as piezoelectric type, electrically conductive type, server type, etc. Among these, from the point of view of practicality, an example which uses a piezoelectric type is going to be explained.
[0069] A piezoelectric vibration sensor produces electric signals by the piezoelectric effect when it perceives mechanical vibration. When a force F is applied to a piezoelectric element of a rectangular parallelepiped, an electric charge Q indicated by formula 2 below is produced between electrodes.
[0070]
math formula 2
$Q = d \times L \times F/T$
In the above formula,
d: piezoelectric constant
L: measurement of piezoelectric element in direction F
T: thickness of piezoelectric element
Accordingly, the open end voltage V0 generated between electrodes is indicated by formula 3 below when the static capacity of the piezoelectric element is adopted as C, electric conductivity is adopted as ε, and the dimension of the piezoelectric element in the perpendicular direction from direction F is adopted as W.
[0071]
math formula 3
$V0 = Q/C = d \cdot F/(\varepsilon \cdot W)$
Voltage V0 is proportional to force F.
[0072] When the output voltage of the piezoelectric vibration sensor is amplified, the applied force can be measured. When it is integrated, the time that the force has been applied can be measured.
[0073] Next, operation of the 4th example of practice is going to be explained referring to the block diagram in figure 13 and the wave figure in figure 14. The wave figure in

figure 14 shows an examples of 3 kinds of (jp1), (jp2), and (jp3). (a) shows the detected output voltage; (b) shows this output voltage amplified and squared (a); (c) is the flattened electric signal (b); (d) is the vibration (c) in real time units. Accordingly, the vibration energy of the detected outputs (jp1), (jp2), (jp3) are 127, 327, 177, adding up to 631. When it is recorded in this way, data to be analyzed such as the total vibration energy of the device, length of time the force was applied, metal fatigue of the device, etc., can be accumulated.

[0074] In figure 13, multiple vibration strain detectors 61 are furnished on the main body of the device. Vibration strain detectors 61 consists of amplifiers 61b which amplify the output voltage detected by the sensor 61a, a square part 61c which squares this, and a flattening part 61d which flattens the signal. It outputs the detected electric signals. Vibration detected by the vibration strain detectors 61 is sent to an A/D converter101, and it is transformed to digital vibration data. This value is supplied to the random access memory (RAM) as address data. RAM 102A is address-assigned by the output of the A/D converter 101, and it has an area Ma which contains the vibration data for each surface and near vicinity, an area Mo of read only memory (ROM) 102B which contains comments. Vibration data read from RAM102A is sent to a character generator 103, and its content is transformed to data for display on the matrix display 104, then it is read into a latch 105. Data read into the latch 105 is written to random access memory (RAM) 106 in order. The content of RAM 106 is sent to the display driver 107 and is transformed to display data and displayed on the matrix display 104. Vibration data read from RAM102A is input to the control part 108.

[0075] The control section 108 compares the specification for the device that has already been written in RAM102A and the value of the vibration energy and timing of the force and judges whether they are within the range of the specification value. The control section 108 outputs a command signal to the character generator 103 and latch 105 based on a signal from the key input part 109 and outputs command signals to control each function such as the display driver 107, etc.

[0076] The comment data calling section 110 sends comment data from the control section 108 to area Mo of ROM 102B as address data, and it calls out comment data from its assigned address area and supplies it to the D/A converter 111. This D/A converter 111 transforms comment data read from ROM102B to analog voice signals and sends it to a speaker 113 via an amplifier 112 to generate a warning sound.

[0077] In the portable electronic device in the 4th example of practice, as explained above, since vibration is experienced during carrying as well as during use, voltage is supplied to the detection and memorizing section for vibration from power maintenance. When the user turns on the main power source when the device is started, power is automatically supplied to the warning display or another step to warn the user. When the capacity of the maintenance power source is sufficiently large, this is not necessary.

[0078] In the 4th example of practice, the same effect as the 3rd example of practice can be acquired. When the device has trouble due to vibration during transportation, recorded proof of the vibration can be confirmed. Before the user starts carrying the device, it warns the user that the device has experienced excess vibration, and to be more careful.

[0079] Next, a 5th example of practice of this invention is going to be explained. The 5th example of practice has the following characteristics. It has a step to automatically detect

vibration strength such as a semiconductor thin film magnetic resistance element type displacement sensor, a step to amplify the voltage output from the vibration sensor and send the output to an A/D converter.

[0080] Instead of the vibration detector in figure 13 in the 4th example of practice, the 5th example of practice uses a semiconductor thin film magnetic resistance element type displacement sensor to automatically detect vibration strength. Since the other construction is the same as the 4th example of practice, its detailed explanation is omitted here.

[0081] In the 4th example of practice, vibration energy was detected. In the 5th example of practice, displacement strain is detected, which is different from the 4th example of practice.

[0082] In order to explain detection of displacement strain applied to a portable electronic device over a long period of time, this example uses a non-contact type displacement sensor – a magnetic resistance element which uses a semiconductor thin film.

[0083] A non-contact type displacement sensor uses a magnetic resistance effect where the electrical resistance of a semiconductor is increased in a magnetic field and detects strain by a change in the magnetic field. When a magnetic field is applied perpendicularly to the surface of the magnetic resistance element with an electrode attached on both ends of small piece of semiconductor, resistance between electrodes is increased. Especially, this increase in resistance is remarkably high for the semiconductor material InSb (indium antimony).

[0084] The construction of the non-contact type displacement sensor of differential motion type magnetic resistance element 70 is shown in figure 15. The magnetic flux passes two quadrant elements of the receiver 73 in different motion by relative movement of the countering magnet 71 and magnetic resistance element 72 as shown in figure 16. When an input voltage E1 is applied between terminals 74a and 74c from the power source 75, an output voltage E2 appears between terminal 74a, 74b, and the displacement sensor circuit of figure 17 detects displacement. Since there is no contact point with the magnetic resistance element 72, this type of displacement sensor can be used for a long period of time. Also, there is no contact resistance or friction, it is immune to noise, and power consumption is small.

[0085] In the 5th example of practice, the semiconductor thin film magnetic resistance element displacement sensor above is attached to the portable electronic device in three directions - left-right, up-down, and front-back. The output voltage from the detected displacement in 3 directions is amplified and sent to an A/D converter. Other than that, it has a step which automatically records the accumulated vibration fatigue for the device, a step which automatically judges whether the device can be used or not, a step which displays a message when the device is judged to have failed, a step to stop the device just like the 4th example of practice, and it makes the user acknowledge whether device can be used or not.

[0086] As a specific example of the step to stop device, stopping the clock pulse or vibration pulse to the controlling section 13 in figure 1 have been considered. In a displacement sensor, when a change in the magnetic field due to displacement strain is detected, the resistance value is considerably increased. Because of that, when the voltage of the comparison circuit is exceeded, the output of comparison circuit is started.

With this output signal, the clock pulse of the device which has a terminal such as reset or a vibration pulse which controls and drives the micro processor (MPU) of the device controlling section 13 is stopped. When displacement strain other than allowed motion is experienced, the MPU will stop. However, the memory contents are not destroyed, and data in the main memory can be protected.
[0087] As is obvious from the 5th example of practice, by using a semiconductor thin film magnetic resistance element type displacement sensor, vibration strength is detected. The amplitude of the output voltage detected by the displacement sensor is amplified, and electric signals are sent to an A/D converter and output. After the accumulated vibration fatigue is recorded, a judgment is mad whether the device can be used or not. When the device is judged to have failed, a message is displayed. At the same time, the device is stopped, and whether the device can be used or not is confirmed. Therefore, the user will not continue using the device in same manner, and proof of vibration damage can is recorded. Before the user starts using the device, a warning of vibration strain and a request for better handling can be sent to the user. The device can be stopped before it is damaged, and better handling of the device is promoted.
[0088] When the device is judged to have failed, a message is displayed and the device is stopped at the same time. Therefore, when the displacement sensor detects a change in magnetic field due to displacement strain, the resistivity value is remarkably increased. If the voltage of the comparison circuit is exceeded because of that, output of the comparison circuit is started. This output signal stops the clock pulse of the power source which has terminals such as reset or the vibration pulse which controls and drives the micro processor (MPU) control section. When displacement strain other than approved motion is applied, the MPU will stop. However, the memory contents are not destroyed and data in the main memory can be protected.
[0089] Next, the 6th example of practice is going to be explained. In the 6th example of practice, as in the 4th example of practice above, there are steps which automatically detect the vibration strain consisting of a vibration sensor, and a step which automatically records the accumulated vibration fatigue to the device. There are also steps which automatically judge whether the device can be used or not by comparing the signal with a 1st reference value (impact specification value), a step which displays warnings based on the 1st judgment, a step which automatically determines that the device has failed by comparing the sensor output with a 2nd reference value, and a step which stops the device at the same time it displays the message based on the 2nd reference value. This example determines whether the device can be used or not and displays a suitable warning.
[0090] Operation of the 6th example of practice is going to be explained referring to figure 18. The same as the 4th example of practice in figure 13, multiple vibration strain detectors 61 are furnished with the main body of the device. The vibration strain detectors 61 amplify the amplitude of the output voltage detected by the vibration sensor. After squaring this, a flattened electric signal is output (S3-1). Vibration detected by the vibration detectors 61 is sent to an A/D converter 101 and is transformed to digital vibration data. These number values are supplied to RAM 102A as address data. This value TX, accumulated vibration fatigue is recorded automatically and regularly (S3-2). The vibration strain limit specification for the device is adopted as the 1st vibration energy reference value T1; the vibration strain limit specification is adopted as the 2nd vibration

energy reference value T2, and they are set beforehand and are input and are memorized in ROM102B. TX is compared to the 1st vibration energy reference value T1 (S3-3). In other words, if TX < T1, normal use can continue, and "can be used continuously" is lighted on (S3-5). Meanwhile, if TX ≥ T1, TX is compared with the 2nd vibration energy reference value T2 (S3-4). That is, if TX ≥ T2, it exceeds the vibration strain limit specification of the device, and the device cannot be used. If it is continued, there is a possibility that the device will be damaged, so some functions are automatically stopped. (S3-6) It is possible for the accumulated vibration fatigue to become TX ≥ T2 when the device is carried or transported rather than during use. The user will know that "the device or function is stopped " when the power is turned on. In other words, "do not use" is displayed for a certain period of time after the power is turned on. (S3-7)

[0091] In step (S3-4), if TX<T2, it is judged that vibration is within the vibration strain limit specification for the device, and the device can be used continuously. However, since it has exceeded the vibration strain limit specification for the device, the user must be aware of the situation, and the device is used at the user's own risk. Accordingly, although continued use is possible, a warning or instruction is displayed by "warning comment" (S3-8), a "warning display lamp" is turned on and off (S3-9), a "warning voice (such as a buzzer)" warns the user to use caution in handling (S3-10), and a warning action such as "warning comment display" or "warning voice" continues until it is reset (S3-11). If the device is in use or being transported at that moment, it is reset immediately, and the "warning comment display" and "warning voice" are stopped (S3-12), the "warning display lamp" continues to be turned on and off (S3-13). However, if the device is being transported in a vehicle, the warning voice continues without reset (S3-14), if it is not reset for certain period of time, the device is automatically protected (S3-15).

[0092] The 6th example of practice, as stated above, controls vibration in two steps. Rather than stopping the device after detection by one step, the accumulated vibration fatigue received by the device can be confirmed at an earlier stage so the user will not continue using the device in the same manner and will cope with trouble quickly following the warning command. The user will avoid continuous vibration by moving the device and putting the soft cover on. After that, it is in an appropriate environment again, and all function can be retained normally as before without device failure, and durability and the useful life of the device can be extended.

[0093] For instance, when wear and deterioration occur in gears, belts, or springs in a paper feeder of a portable electronic device due to accumulation of continuous strain over a long period of time, paper is not sent normally, and this will cause problems such as misalignment of the printing or bad spacing between printed letters. Because of accumulated vibration, gears or belts or springs are worn prematurely, and eventually the device cannot be used any more.

[0094] Users think that their handling of the device cannot be confirmed as normal or abnormal, and users with rough handling habits think that their manner is correct. For example, if vibration damage is accumulating faster than normal and handling is abnormal, the user will be warned to pay attention by the "warning comment" enabling the user to satisfied with the device.

[0095] When the vibration strain limit specification is exceeded due to an accumulation of abnormal vibration, the device is judged to be unusable. Since there is a possibility for further damage, the device or partial function is automatically stopped.
[0096] For instance, when electric wiring or a printed substrate is damaged, or the terminals in the power supply for a portable electronic device are loosened due to accumulated vibration after a long period of time, proper voltage cannot be supplied. This will cause trouble in each part of the device, or may be dangerous to the user such as fire. The user cannot confirm whether the current condition of device is normal or abnormal. Continued use can be avoided by automatic shut down of the device or partial function.
[0097] As seen in the 6th example of practice, having two steps of vibration strain detection and two steps of warning display are for informing the user. Continuous use after receiving the 1st warning that he device has exceeded its vibration strain limit is at the user's own risk, and it makes clear that accidents are not the responsibility of the device or manufacturer of the device.
[0098] According to 6th example of practice, it is possible for the user to take good care of the device during transportation or carrying and to prevent problems that may occur due to continuous use in that situation. At the same time, it warns the user to avoid using the device in a bad environment.
[0099] In addition, the vibration strain detectors 61 in 6th example of practice can be the strain gauges as stated above, a pressure sensitive film, pressure sensitive conductive rubber, vibration sensors, a semiconductor thin film magnetic resistance element type displacement sensor, etc.
[0100] Next, a 7th example of practice of this invention is going to be explained. The 7th example of practice has a characteristic step to detect either impact or strain on the surface of the device and a step to display the detected result and advice about whether the device can be used or not. A product which can be used fro both functions is pressure sensitive measuring film. In the 7th example of practice, this pressure sensitive measuring film is applied to the surface of the device.
[0101] The color of a pressure sensitive measuring film changes corresponding to physical impact force. According to this, the distribution of contact pressure in a narrow spot such as between parts that used to be impossible to measure in the prior art can be easily checked by looking at the color tones. The value of the impact fore can also be determined from the color concentration. A specific example of pressure sensitive measuring film is "Prescale" manufactured by Fuji Film Co. Ltd.
[0102] Figure 19 shows the construction and principle of a pressure sensitive measuring film. Micro capsules 82a of color emitting agent 82 in a film 83 are applied to a support 80 consisting of polyester film, a middle layer 81, and a coloring agent layer 82 which is destroyed by impact. A clear coating 82b is applied to the color developing agent layer 86 of C film 87 which consists of a support 84 consisting of polyester film, a middle layer 85, and a color developing agent layer 86, and it emits color by chemical reaction (part B). Since the micro capsules 82a in the color emitting agent layer 82 are adjusted to various strength, the color concentration depends on impact strength. Because of this, the distribution of impact loading on the surface can be found from the color tone and the impact strength can also be found from the color concentration (refer to figure 20).

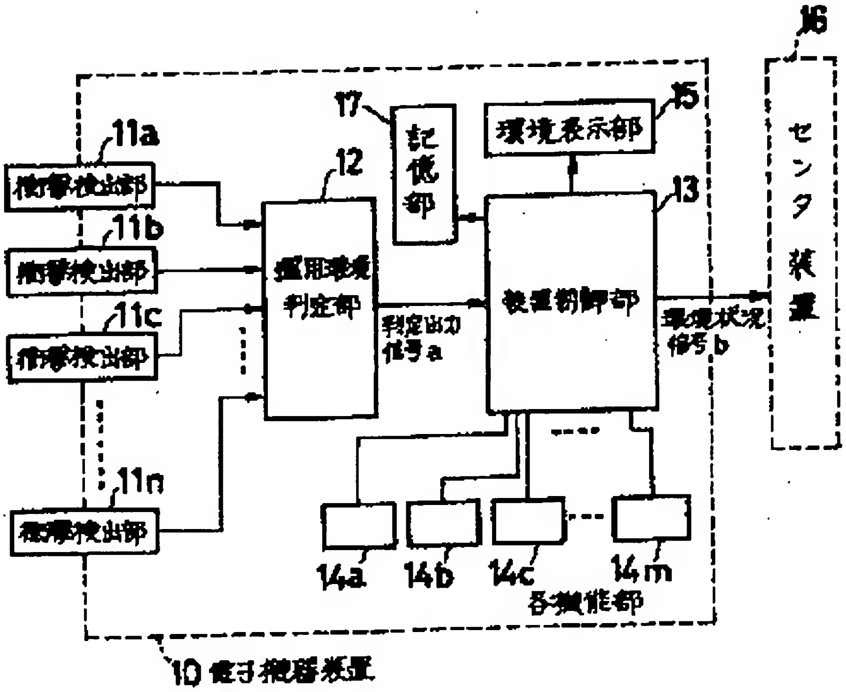
[0103] If strain is detected by applying a pressure sensitive measuring film on the surface or corner of the device, a power source or circuit is not necessary. Since the shape can be changed freely, it can be applied to areas such as surfaces or corners of the device that are to be measured. In addition, distribution of impact strength over the whole surface can be seen at a glance, and the impact value can be measured. A record of the measured result can be stored, and it is non-reversible. Measurement is an easy operation.
[0104] When the user drops the device and the device fails to work due to the accident, proof of impact can be confirmed at one glance. Also, in this case, even if the device does not have trouble, the record of this fall impact reminds the user to be more careful. Since the film can be reapplied, material can be selected which matches the impact resistance specification for the application.
[0105] Also, in the 1st to 7th example of practice above, as long as the detection step detects at least impact or strain, similar effects can be acquired, and this invention is not restricted to the construction in each example of practice. In addition, it is possible to obtain even more effective protection by combining these examples appropriately.

[0106]
(Effects of this invention)
As explained above, according to the construction in claims 1, 4, 5, 6, 7, 8, 9, impact and strain on or near the surface of an electronic device are detected, and whether the device can be used or not is judged from the detected output. When failure of the device is judged, this fact is displayed and is the user is informed. At the same time, operation of the device can be stopped. Use, storing, and transportation of the device under inappropriate environmental conditions can be prevented. In addition, problems or accidents such as smoking or fire due to continued use of the device are avoided, and it can improve reliability of the device and improve its useful life.
[0107] According to construction in claims 2, 4, 5, 6, 7, 8, 9, in addition to the above effects, two step control can be performed. Therefore, rather than stopping device after one step detection, the accumulated fatigue received by the device can be confirmed earlier, so the user will not continue using the device in same manner and will cope with the trouble quickly following the warning. The user will avoid continuous vibration and move the device and put on the soft cover. After that, the environment is suitable again, and all functions can be retained without failure of the device, and durability and life of the device can be improved.
[0108] According to the construction in claim 3, when the device returns from a non-usable condition to a usable condition, this is judged, and each part is automatically set to a re-usable condition. Therefore, the device is easy to use.
[0109] According to the construction in claim 9, accumulated fatigue can be automatically recorded. Whether the device can be used or not can be reliably determined by the recorded data. These recorded contents can be used for promoting better handling.
[0110] According to the construction in claim 10, by displaying impact and strain by using a non-reversible pressure measuring film, whether device can be used or not is judged at a glance. A permanent record of the impact becomes possible. The film can be reapplied to match the impact resistance or object of use easily.

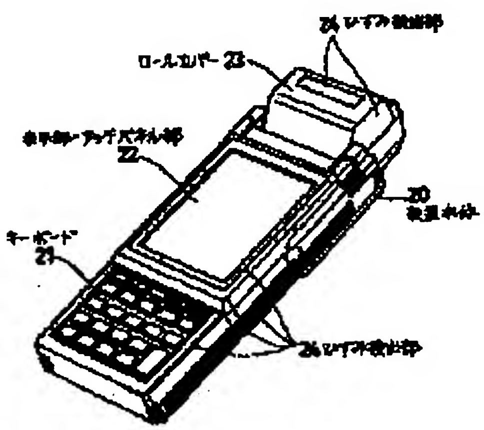
(Simple explanation of figures)
Figure 1: Block diagram of the 1st example of practice of a portable electronic device of this invention.
Figure 2: Block diagram which shows the construction of the display step, informing step of this invention.
Figure 3: Flow chart of the 1st example of practice.
Figure 4: Cross section of the 2nd example of practice of this invention.
Figure 5: Construction of the vibration strain detectors of the 2nd example of practice.
Figure 6: Flow chart of the 2nd example of practice.
Figure 7: Characteristics of the pressure sensitive conductive rubber in the 3rd example of practice.
Figure 8: Principle of the pressure sensitive conductive rubber.
Figure 9: Construction of the pressure sensitive conductive rubber in the 3rd example of practice in use.
Figure 10: Construction of the pressure sensitive conductive rubber in the 3rd example of practice in use.
Figure 11: Construction of the pressure sensitive conductive rubber in the 3rd example of practice.
Figure 12: Detection circuit connected to the pressure sensitive conductive rubber.
Figure 13: Block diagram of the vibration strain detector in the 4th example of practice.
Figure 14: Used to explain the 4th example of practice.
Figure 15: Cross section of a non-contact differential magnetic resistance element in the 5th example of practice.
Figure 16: Explains the operation of the non-contact displacement sensor in figure 15.
Figure 17: Explains displacement detection using the non-contact type displacement sensor in figure 15.
Figure 18: Flow chart of the 6th example of practice.
Figure 19: Explains the construction of the pressure measuring film in the 7th example of practice.
Figure 20: Explains the detection display of the pressure measuring film in figure 19.

(Explanation of symbols in figure)
10: portable electronic device, 11a to 11n: impact detectors, 12: application environment judgment part, 13: device controller, 14a to 14m: functions, 15: environment display, 16: center device, 17: memory, 20: main body of device, 22: display and touch panel, 24: strain detector, 30: pressure sensitive conductive rubber, 61: vibration strain detector, 70: non contact type displacement sensor, 88: pressure measuring film, 101: A/D converter, 102, 102B: ROM, 102A: RAM, 103: character generator, 104: matrix display, 105: latch, 106: RAM, 107: display driver, 108: control section, 110: comment data calling section, 111: D/A converter, 112: amplifier, 113: speaker

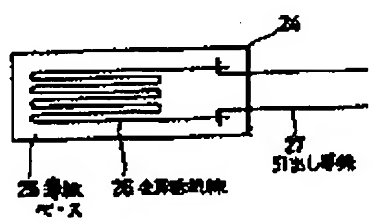
【図1】


16
センタ装置
17
記憶部
15
環境表示部
11a
衝撃検出部
12
11b
衝撃検出部
13
運用環境判定部
装置制御部
11c
衝撃検出部
判定出力信号a
環境状況信号b
11n
衝撃検出部
14a
14b
14c
14m
各機能部
10 携帯機器装置

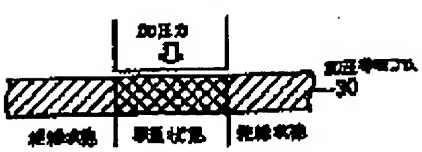
【図4】


24 ひずみ検出部
ロールカバー 23
表示部・タッチパネル部
22
20
装置本体
キーボード
21
24 ひずみ検出部

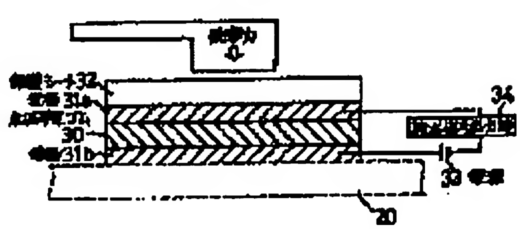
【図5】


24
27
引出し導線
25 絶縁ベース
26 金属抵抗線

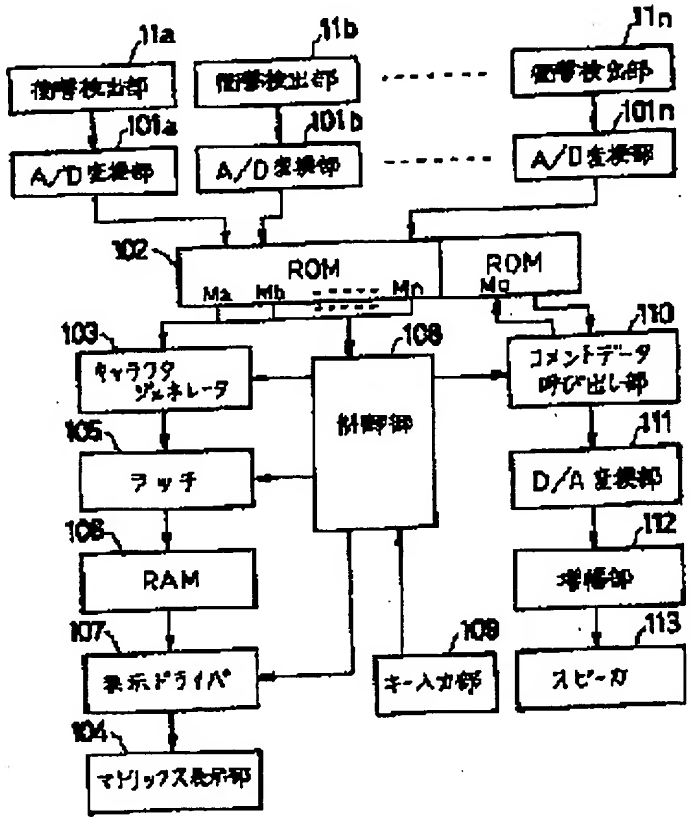
【図8】


加圧力
加圧導電ゴム
30
絶縁状態
導通状態
絶縁状態

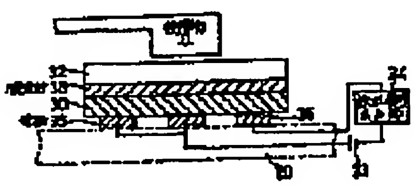
【図9】


衝撃力
保護シート32
電極31a
加圧導電ゴム
30
電極31b
34
33 電源
20

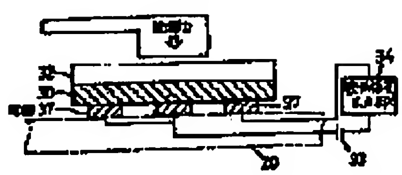
【図2】


11a
11b
11n
衝撃検出部
衝撃検出部
衝撃検出部
101a
101b
101n
A/D変換部
A/D変換部
A/D変換部
102
ROM
Ma
Mb
Mn
ROM
Mo
103
キャラクタジェネレータ
108
制御部
110
コメントデータ呼び出し部
105
ラッチ
111
D/A変換部
106
RAM
112
増幅部
107
表示ドライバ
109
キー入力部
113
スピーカ
104
マトリックス表示部

【図10】



【図11】



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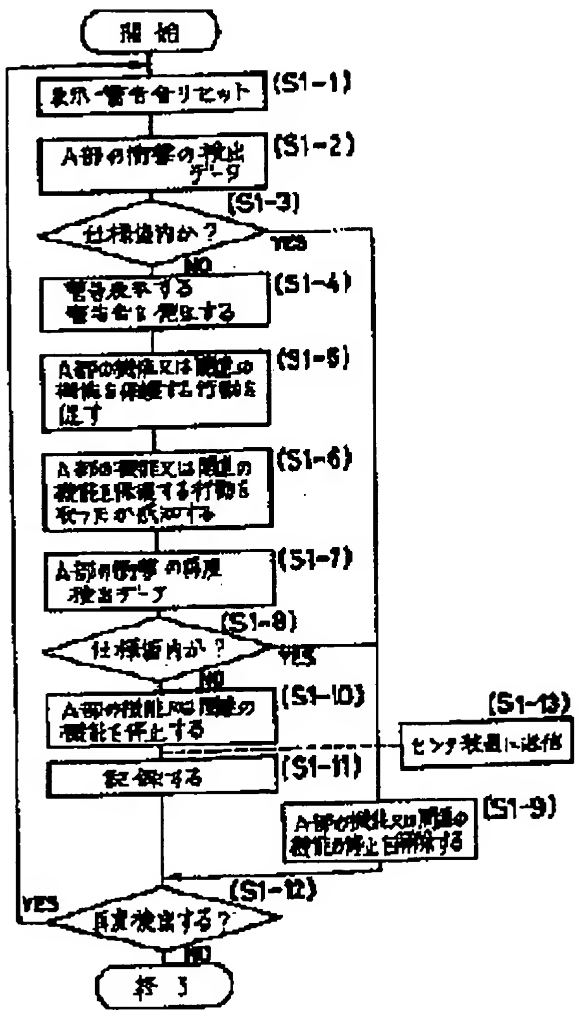
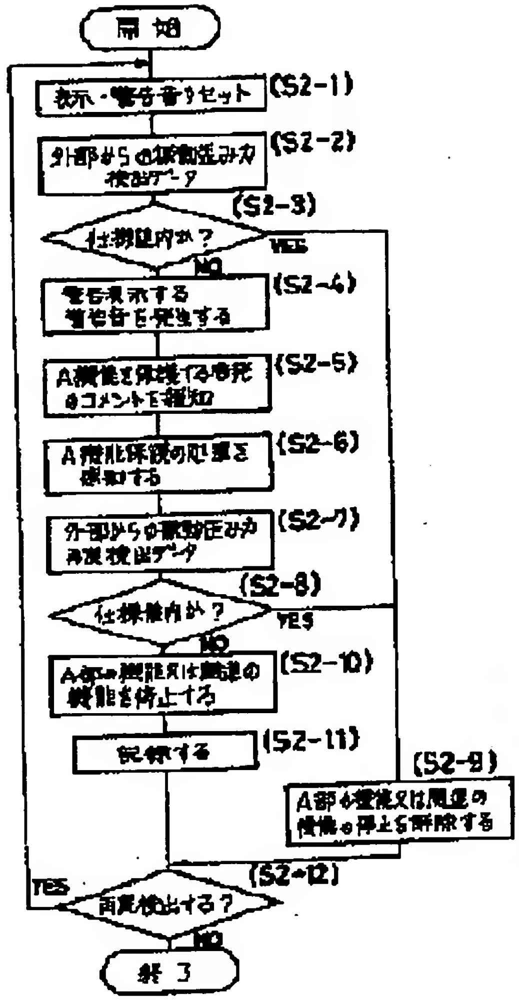
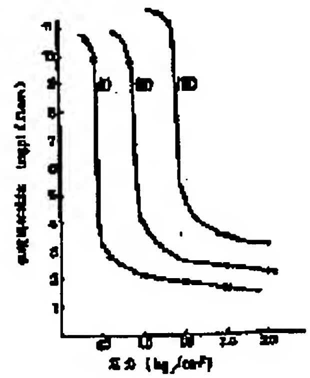

開始
表示・警告音リセット
(S1-1)
(S1-2)
(S1-3)
YES
NO
(S1-4)
(S1-5)
(S1-6)
(S1-7)
(S1-8)
YES
NO
(S1-10)
(S1-13)
センタ装置に送信
記録する
(S1-11)
(S1-9)
(S1-12)
YES
NO
終了

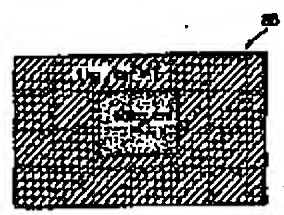
【図6】



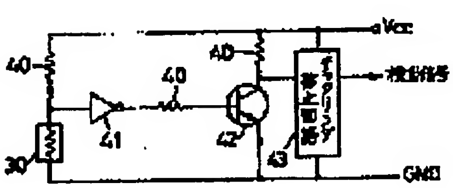
【図7】



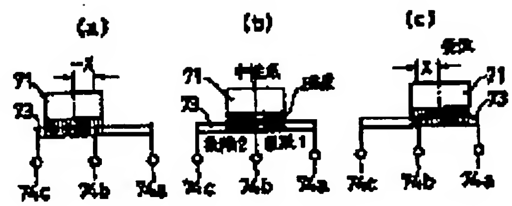
【図20】



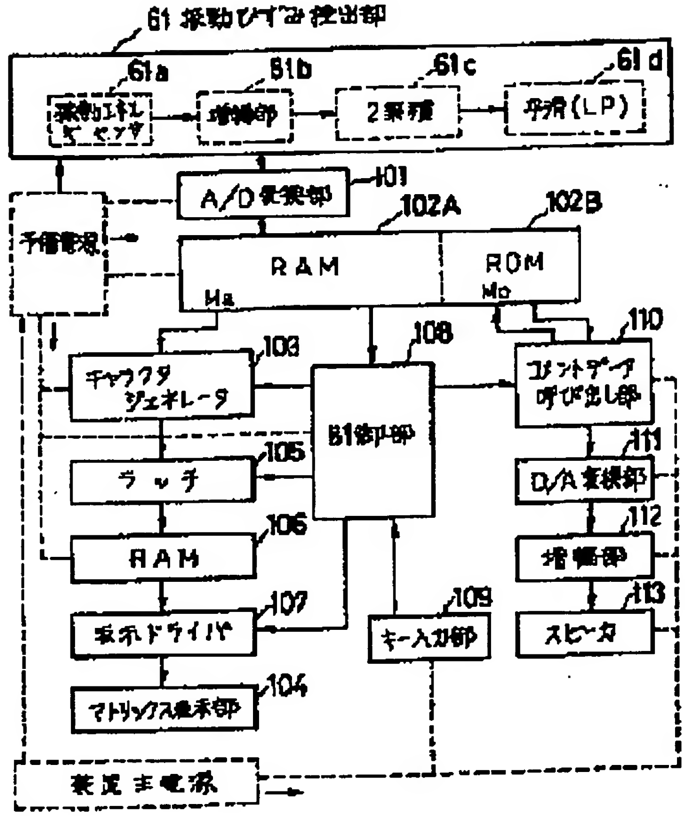
【図12】



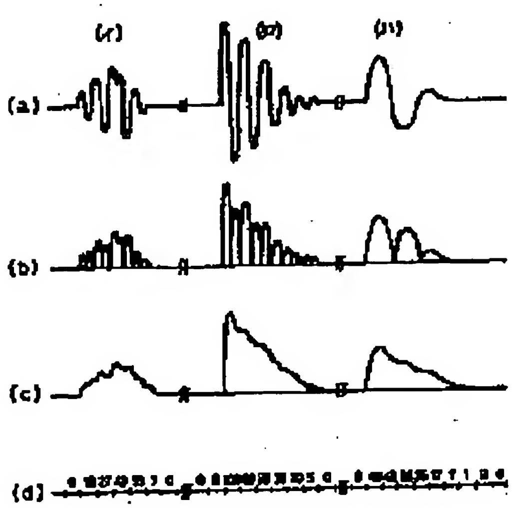
【図18】



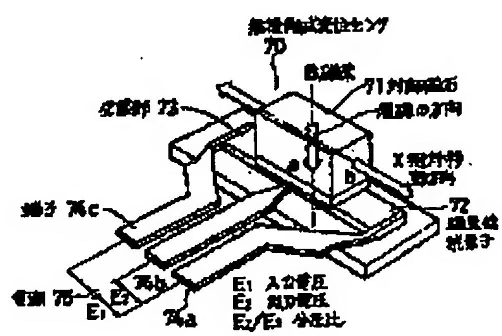
【図13】


61 振動ひずみ検出部
61a
61b
61c
61d
増幅部
平滑(LP)
101
A/D変換部
102A
102B
予備電源
RAM
ROM
Ma
Mb
103
キャラクタジェネレータ
108
110
コメントデータ呼び出し部
111
D/A変換部
112
増幅部
113
スピーカ
105
ラッチ
106
RAM
107
表示ドライバ
109
キー入力部
104
マトリックス表示部
装置主電源

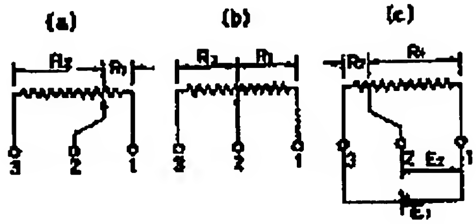
【図14】


(イ)
(ロ)
(ハ)
(a)
(b)
(c)
(d)

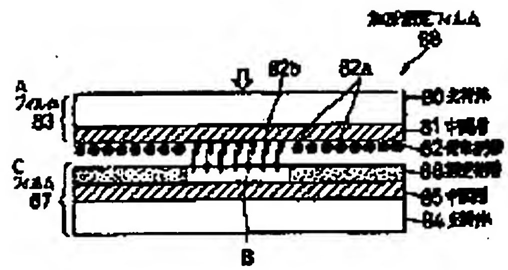
【図15】


70
71
72
73
74a
74b
74c
75
E1 入力電圧
E2 出力電圧
E2/E1 分圧比

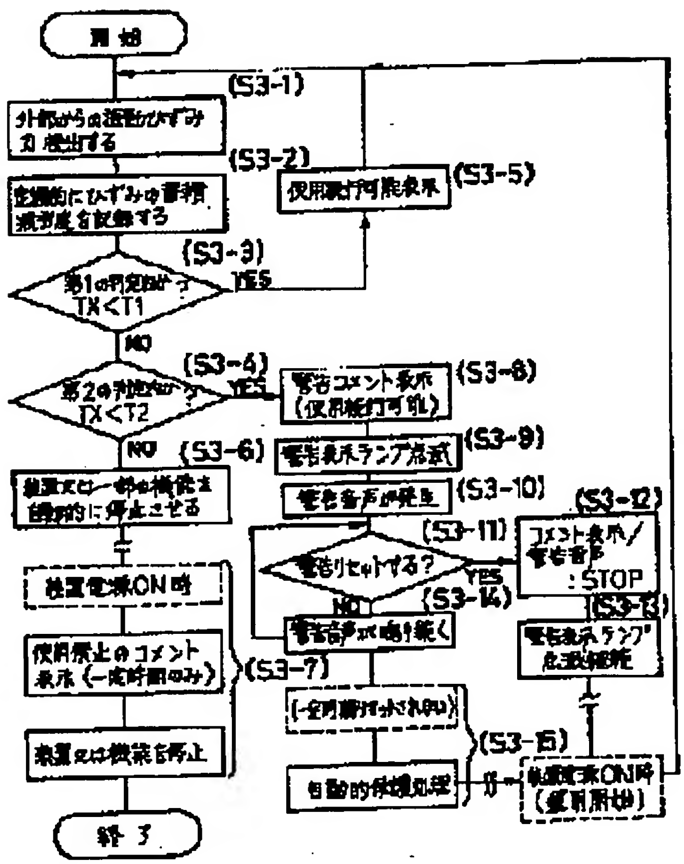
【図17】


(a)
(b)
(c)
3
2
1
STOP

【図18】


A
C
B
82b
82a
88
80
81
82
85
84
83
87

【図16】


開始
(S3-1)
(S3-2)
(S3-3)
TX<T1
YES
NO
(S3-4)
TX<T2
YES
NO
(S3-5)
(S3-6)
(S3-7)
(S3-8)
警告コメント表示
(S3-9)
警告表示ランプ点滅
(S3-10)
(S3-11)
(S3-12)
コメント表示/
:STOP
(S3-13)
(S3-14)
(S3-15)
終了